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<p>(54) Title: SCREEN FOR PRODUCING A PERFORATED FILM</p> <div data-bbox="305 1163 1312 1444"> </div> <p>(57) Abstract</p> <p>The invention is directed to a cylindrical screen (14) for perforating a thermoplastic film (17) or sheets. The screen (14) is formed from a relatively thin sheet (31) that is secured together to form a cylindrical shape. A plurality of apertures (41) are positioned in the sheet (31) and the apertures (41) in the sheets (31) form a passageway (45) through the screen (14). The passageways are disposed at an angle from about 5° to about 60° with respect to a plane (47) that is disposed substantially perpendicular to the surface (39) of the screen (14).</p>		

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## SCREEN FOR PRODUCING A PERFORATED FILM

### DESCRIPTION

#### BACKGROUND ART

5 The present invention is in the general field of perforated plastic film and especially relates to perforating of plastic film. The invention particularly relates to perforated plastic film, the metal screens or molding elements used in the vacuum perforation of plastic film and to a method of fabricating such screens.

10 Perforated plastic film has many useful applications. It is used in gardening and farming to prevent the growth of grass and weeds while permitting moisture to be transmitted through the film to the soil beneath. Perforated films have a multiplicity of regularly spaced apertures which allow permeation of liquid and air or other fluids. Such films can be used as a component of disposable garments for sanitary  
15 apparel purposes, such as napkins, diapers, or for hospital pads, bed or sleeping bag linings, and the like. In such composite structures, an exterior layer of film having the desired properties is provided which would be adjacent to the skin in a composite garment, and the garment would also include a filler layer or layers of absorbent fibrous material.  
20 An example of the use of perforated film for making disposable diapers is shown in U.S. Patent No. 3,814,101.

A particular class of perforated film is described by Thompson, U.S. Patent No. 3,929,135, issued December 30, 1975. Thompson teaches an absorptive structure with a top layer of perforated film  
25 characterized by having a series of regular spaced small apertures in the form of tapered capillaries of certain dimensions ranges. In the finished article, these are directed inwardly to be in intimate contact with an absorbent fibrous material layer. The smooth side of the perforated film is thus in use in contact with the skin. Film as described by Thompson,  
30 in garment structure as outlined, maintains a dry and comfortable

condition, even after transmission of fluids to the absorbent layer by the combined effects of the absorption and the resistance to back flow as a result of the relative length and surface properties of the tapered capillaries.

5           One of the earlier methods for vacuum perforation of plastic film is disclosed in U.S. Patent No. 3,054,148. The patentee describes a stationary drum having a molding element or screen mounted around the outer surface of the drum and adapted to freely rotate thereon. A vacuum chamber is employed beneath the screen to create a pressure  
10 differential between the respective surfaces of the thermoplastic sheet to be perforated to cause the plasticized sheet to flow into openings provided in the screen and thereby cause a series of openings, holes or perforations to be formed in the plastic sheet or film.

          One method for making film with tapered capillaries on one side  
15 thereof is shown in U.S. Patent No. 3,054,148 issued September 18, 1962, to Zimmerli. In this patent heated film is supported by a perforated screen and a vacuum applied to the underside of the perforated screen. Holes are pulled in the film in the direction of the vacuum beneath the screen thereby forming tapered capillaries in the  
20 film.

          A variety of methods and apparatuses including particular types of perforating screens or rotatable molding elements have been developed over the years for particular perforation operations. Examples of these are U.S. Patent Nos. 4,155,693; 4,252,516; 3,709,647; 4,151,240;  
25 4,319,868 and 4,388,056. In U.S. Patent No. 4,155,693, the screen is comprised of a series of perforated metal strips preferably welded together to form a cylinder. U.S. Patent No. 4,252,516 provides a screen having a series of hexagonal depressions with elliptical holes centered therein. U.S. Patent No. 3,709,647 provides for a rotating  
30 vacuum-forming roll having a circulating cooling medium therein.

U.S. Patent No. 4,151,240 provides a means for cooling the film after it has been perforated and debossed. U.S. Patent No. 4,319,868 sets forth an apparatus for making a thermoplastic film having raised bosses with perforated tips. A particularly constructed embossing roll for effecting the desired film pattern is disclosed. U.S. Patent No. 4,388,056 discloses an apparatus for continuously forming an air-laid fibrous web having oppositely phased, cylindrically undulating side edges and a predetermined basis weight distribution. An air-laying drum has a honeycomb-type annular-shape frame including circumferentially extending ribs and transverse plates. A stationary adjustable air flow modulating means is disposed adjacent the radially inwardly disposed boundary of an arcuate portion of a circumferentially segmented annular-shape plenum, circumferentially spanning a plurality of plenum segments for adjusting a pressure drop across particular areas of the surface of the air-laying drum.

Vacuum perforation of thin plastic films involves the extrusion of molten polymeric materials such as polyethylene and other plastic polymers through a die. The hot melt web of film or plastic sheet exiting the die impinges on a rotating cylindrical screen which is mounted on a stationary vacuum drum or roll. The vacuum roll has an axial slot and a set of seals extending longitudinally along the length of its inside surface, beneath the area where the web of plastic impinges on the screen or molding element. A vacuum from inside the screen is directed through the slot in the vacuum roll. The vacuum present within the slot forms or molds the plastic film or sheet to the screen and perforates it through the holes of the screen. At the same time, an airflow is produced which cools the film.

An important component of the vacuum processing equipment is the cylindrical screen. This molding element defines aesthetic, tactile and mechanical properties of the film as well as the geometric pattern of the

perforated film. In a preferred screen fabrication technique, the desired screen pattern is nickel plated on a specially prepared cylindrical mandrel. A seamless cylindrical nickel screen of any predetermined or desired pattern can be produced. Other metals, such as copper may also be  
5 used.

However, the prior art screens produce film with perforations that extend through the film at substantially a right angle to the surface of the film. Such perforations provide a direct line of sight and a direct path through the film. This feature of the prior art film is undesirable when  
10 the film is used in catamenial or incontinent applications as the collected fluid remain visible. Accordingly, there is a need for a perforated film having masking characteristics that reduce the visible presence of the collected fluids.

It is also desirable to have a film that does not provide a direct  
15 path through the film for fluids. Such a film can be utilized for protective clothing as fluids contacting the surface of the film will not have a direct path through the film. Such a characteristic greatly improves the protective quality of the clothing.

## 20 DISCLOSURE OF THE INVENTION

The invention is directed to a cylindrical screen for perforating a thermoplastic film or sheets. The screen is formed from a relatively thin sheet that is secured together to form a cylindrical shape. A plurality of apertures are positioned in the sheet and the apertures in the sheets  
25 forms a passageway through the screen. The passageways are disposed at an angle from about 5° to about 60° with respect to a plane that is disposed substantially perpendicular to the surface of the screen.

### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic elevational view showing the inter-relationship of the principle pieces of equipment employed in carrying out the process.

5        Fig. 2 is an enlarged, sectional view showing a segment of the forming surface as employed in the process.

Fig. 3 is an enlarged, schematic, sectional view of a prior art perforated film having straight capillaries.

10       Fig. 4 is an enlarged, schematic, sectional view of a prior art perforated film having tapered capillaries.

Fig. 5 is a cross-sectional view of a film forming screen of the present invention.

Fig. 6 is a cross-sectional view of a perforated film made using the screen of Fig. 5.

15       Fig. 7 is a cross-sectional view of a perforated film made using the screen of Fig. 11.

Fig. 8 is a cross-sectional view of a perforated film made using the screen of Fig. 12.

20       Fig. 9 is a cross-sectional view of a perforated film made using the screen of Fig. 10.

Fig. 10 is a cross-sectional view of a film forming screen.

Fig. 11 is a cross-sectional view of a film forming screen.

Fig. 12 is a cross-sectional view of a film forming screen.

25       Fig. 13 is a cross-sectional view of a fabric containing the perforated film of the present invention.

Fig. 14 is a protective gown using the fabric of Fig. 13.

Fig. 15 is a facemask using the fabric of Fig. 13.

Fig. 16 is a cross-sectional view of an absorbent pad or drape.

Fig. 17 is a cross-sectional view of an absorbent pad or drape.

30       Fig. 18 is a cross-sectional view of a landscape fabric.

Fig. 19 shows a catamenial pad construction using the film of the present invention.

Fig. 20 is a cross-sectional view taken along line 20-20 in Fig. 19.

Fig. 21 shows a diaper construction using the film of the present invention.

Fig. 22 is a cross-sectional view taken along line 21-21 in Fig. 21.

### BEST MODE OF CARRYING OUT THE INVENTION

Referring to Fig. 1, an apparatus for carrying out the process of the invention includes a rotary cylindrical drum 10 supported at each end by a centrally disposed axle 11 supported by means of stationary axle supports 12. The cylindrical surface 13 of drum roll 10 is highly perforated to allow air to pass therethrough. The molding element or screen 14 is mounted around the surface 13 of drum 10 and is adapted to rotate with the drum 10.

Element 14 may be formed as an integral unit adapted to be slipped on drum 10 from an end thereof or it may be wrapped around the drum 10 and then affixed thereto in any suitable manner. For purposes of rotating drum 10, a gear drive may be employed which is adapted to mesh with gearing provided on the drum element itself or a pulley drive may be connected to the drum by means of caps provided on the ends thereof. As shown in Fig. 1, a vacuum chamber 15 is utilized to create a pressure differential between the respective surfaces of the thermoplastic sheet to cause the plasticized sheet to flow into the perforations provided in the molding element 14 and therefore perforate the sheet.

Referring to Figs. 1 and 2, the vacuum chamber 15 is positioned within drum 10, along the axis of drum 10 and opens at the surface of the drum over a limited portion of its periphery in contact with the inner portion of surface 13 of drum 10. Two plates 15A define the chamber.



In order to provide an effective seal of the leading and trailing edges of chamber 15, seals 16 are provided in plates 15A to form a seal against the surface 13. The seals may be made of metal, HDPE, rubber or other suitable material. The plates 15A are stationary with respect to the rotational direction of the drum and rigidly affixed to axle 11 or other suitable means so that chamber 15 remains in a fixed or stationary position in drum 10. Thus, chamber 15 is sealed at all points except the peripheral openings on drum 10 and may be evacuated or reduced in pressure by pumping equipment connected to the chamber in any suitable manner.

As can be seen in Fig. 1, located above and adjacent to drum 10 is extruder 21 having a die 8 which is used to extrude a hot thermoplastic sheet 17 onto drum 10. In practice it has been found that polyolefin materials work particularly well as the thermoplastic material that is extruded onto the drum 10. As the sheet material 17 travels downwardly from die 8, the sheet contacts screen 14 which is turning clockwise with drum 10 in Figs. 1 and 2. The rotating screen 14 carries sheet 17 over vacuum slot 15 which causes the thermoplastic material to be drawn into the openings in screen 14 and thereby perforated. The sheet is cooled to change the hot thermoplastic material from its molten state to a solid state and to set the perforations in the film. The sheet 17 continues to travel around in a clockwise manner shown in Fig. 1 on drum 10 and continues on to the rolls 19.

From roll 19 the solid sheet material 18 continues upwardly over roll 21 to corona treating roll 22. The corona treating roll 22 is usually covered with a suitable dielectric material such as epoxy, fluorinated polyethylene (TEFLON), chlorinated polyethylene (HYPALON), OR POLYESTER (MYLAR). However, bare roll treating with a dielectric covered electrode can be utilized to treat the film. The electrode or corona bar 23 is suspended parallel to the treater roll at about 1/16 of an

inch above the roll. The corona bar 23 is energized by a transformer and corona treating power source 24. The sheet continues past a tension roll 25 to a second tension roll 26 and onto wind-up roll 27. It should be understood that the corona treating operation is not required for all applications for the film and this part of the process can be removed. Further, it is not always necessary to wind the film onto a wind-up roll 27 if the film is being put into an end use application in an in-line process.

It should be noted that other forming processes can be utilized to form the perforated plastic films of the present invention. The process shown in U.S. Patent No. 4,878,825 which utilizes a support for the forming screen in the area of the vacuum slot works particularly well in forming the perforated film of the present invention. The process shown in U.S. Patent 4,839,216 that utilizes a high-pressure liquid stream to perforate a plastic film can be also used with the present invention. The teachings of U.S. Patent Nos. 4,878,825 and 4,839,216 are hereby expressly incorporated by reference into this patent application as alternative methods for forming the perforations of the present invention.

Figs. 3 and 4 show prior art types of perforated plastic films that have been produced on the apparatus shown in Fig. 1. This film has straight capillaries 3 as shown in Fig. 3, or tapered capillaries 4 as shown in Fig. 4. In both of these films, the perforations are disposed at substantially a 90° angle with respect to the surface of the film and provide a direct line of sight and a direct path through the film.

One configuration for the screen 14 of the present invention which is utilized to form the perforated plastic film is shown in more detail in Fig. 5. The screen 14 is a laminate structure comprised of a stack of individual sheets 31, 32, 33, 34, 35, 36, and 37. The screen 14 has an outer surface 39 that is disposed to be in contact with the thermoplastic sheet 17 and an inner surface 40 that faces the vacuum chamber 15.

The sheets contain a plurality of apertures 41 that extend through the thickness of the individual sheets. The apertures 41 preferably all have substantially the same geometric shape, however, it should be understood that the shapes of the apertures can be different. The sheets

5 are normally a stainless steel, photo-etched metallic material where the photo-etching has formed the apertures 41 in the individual sheets. The sheets generally have a thickness from about 1 to about 5 mils. In practice it has been found that sheets having a thickness of about 2 mils work particularly well. Usually from about 2 to about 20 sheets are used

10 to form the screen 14. The preferred range for the number of sheets to form a screen 14 is from about 4 to about 10 sheets. The effective diameter of the apertures 41 in the sheets is from about 2 mils to about 100 mils. In practice it has been found that a range from about 7 mils to about 60 mils for the effective diameter of the apertures 41 works

15 particularly well. The sheets of the laminate are bonded to one another at contact points while the laminate is subjected to heat and pressure. The resultant laminate structure is thereafter rolled into a tubular shape and its free edges are bonded to one another to form a continuous tubular-forming structure. As shown in Fig. 5, the apertures 41 in the

20 laminate structure are not concentrically aligned. Instead, the apertures 41 are circumferentially displaced in the same direction to form a passageway 45 through the laminate structure that is disposed at an angle. The apertures 41 shown in Fig. 5 all have substantially the same diameter and each aperture has been displaced from about 1% to about

25 50% of the diameter of the apertures from the aperture on the adjacent sheet with a preferred range of 5% to 25% of the diameter of the apertures. In practice it has been found that a displacement of about 10% of the diameter of the apertures works particularly well. This results in a passageway 45 that is disposed at an angle from about 5°

30 to about 60° with respect to a plane or line 47 which extends

perpendicular to the outer surface 39 of the screen 14. This angle is generally shown as angle A in Fig. 5.

The apertures 41 in the sheets are generally circular in shape and the passageway 45 formed through the laminate screen 14 is generally cylindrical in shape. However, it should be understood that shapes for the apertures can vary and that oval, ellipsoidal and other shapes can be used, and multi-sided figures such as a rectangle, square, hexagon or a pentagon can be utilized for the openings.

As shown in Fig. 10, the screen 14' has apertures 41' that become progressively smaller in each adjacent sheet of the laminate. In this screen structure, the passageway 45' that is formed will converge as the passageway advances through the screen 14'. In this particular structure each aperture 41' is displaced a selected percentage of its diameter from the apertures on adjacent sheets. This results in a passageway 45' that continuously and uniformly converges as the passageway advances through the screen 14'.

The screen 14'' shown in Fig. 11 has apertures 41'' that become progressively smaller as the apertures shown in Fig. 10. However, in Fig. 11, the apertures 41'' are displaced in the screen 14'' as that the passageway 45'' converges in one direction as the passageway advances through the screen 14''.

As shown in Fig. 12, the screen 14''' defines a passageway 45''' that has a compound curve for the passageway. In this embodiment a portion of the sheets that form the screen 14''' are displaced in one direction to form a first portion 51 of the passageway 45''' and a plurality of sheets are displaced in the opposite direction to form a second portion 53 for the passageway 45'''. Normally, all of the apertures 41''' will be of the same diameter and will be displaced a equal distance on each layer of the screen 14'''. However, it should be noted that the apertures 41''' can vary in size and the amount of displacement

can vary to form a converging passageway 45'''. The first portion 51 of the passageway 45''' is disposed at an angle A that is from about 5° to about 60° with respect to a line or plane 47' which extends perpendicular to the outer surface 39''' of the screen 14'''. The second portion 53 is disposed at an angle B that is from about 5° to about 60° with respect to the plane or line 47.

Fig. 6 shows a cross section of a film 54 that has been formed utilizing the screen shown in Fig. 5. The film 54 has a first surface 59 and a second surface 64. The first and second surfaces of the film are usually positioned in substantially parallel relationship. This film has a plurality of perforations 52 that form capillaries 55 in that film. The capillaries 55 have a substantially uniform diameter and are displaced at an angle A from about 5° to about 60° with respect to a plane 47 that is perpendicular to the first surface 59 of the film. The capillaries 55 are substantially cylindrical in shape, have a side wall 62, define a passageway 65, have first opening 58 in the surface 59 of the film 54 and second opening 60 at the end 57 of the capillary 55 that is spaced apart from the first surface 59 of the film 54. The ends 57 of the capillaries 55 are usually spaced apart from the surface 59 of the film 54 by a distance from about .005 to about .05 of an inch with a spacing from about .007 to about .025 of an inch being preferred. The opening 58 and the opening 60 both have a center point or geometric center and the center point of opening 58 is displaced from the center point of opening 60. The center point of opening 60 is displaced from the center point of opening 58 by a distance that is from about 5% to about 200% of the diameter of the opening 60 with the preferred range being from about 75% to about 125% of the diameter of the openings 60. As can be seen in Fig. 6, the capillaries 55 have a plurality of steps or ridges 56 that are produced by the off-set sheets of the screen 14. The ridges 56

in the film 54 are substantially rounded instead of the sharp corners formed by the off-set sheets that form the screen 14.

Fig. 9 shows the cross section of a film 54' that has been formed utilizing the screen shown in Fig. 10. This film 54' is substantially similar to the film shown in Fig. 6 except that the side wall 62', each capillary 55' and the passageway 65' converge as it extends from the first surface 59' of the film.

Fig. 7 shows a cross section of a film 54'' that has been produced using the screen in Fig. 11. In this film the side wall 62'' of the capillaries 55'' and the passageway 65'' converges as it advances away from the surface of the film and in particular converges on one side in one direction.

Fig. 8 shows a cross section of a section of film 54''' produced utilizing the screen shown in Fig. 12. In this figure the capillaries 55''' and the passageway 65''' have a first portion 61 that is disposed at an angle A with respect to a plane 47 that is disposed perpendicular to the first surface 59''' of the film and a second portion 63 that is disposed at an angle B and both angles are from about 5° to about 60° with respect to the plane 47. In Fig. 8 the capillary 55''' generally converges as it advances from the first surface 59''' of the film 54'''. However, it should be understood that the capillaries 55''' can have walls that do not converge.

The above films all have capillaries that are disposed at an angle that acts to block a direct line of sight through the apertures that is perpendicular to the surface of the film. Accordingly, the films will have a masking characteristic such that fluids that pass through the film to an absorbent structure will not be as visible to a user as when the capillaries are perpendicular to the first surface 59 of the film. This is particularly important for catamenial or incontinent applications. The degree of masking produced by the film will be directly proportional to the angle of

the capillaries in the film, their length and the degree to which the capillaries converge in shape. Such films also can be useful in preventing unwanted direct fluid flow through the film. Since the capillaries are disposed at an angle, fluid striking the surface of the film will not have a direct path through the film. Instead, the fluid will have to change direction to pass through the capillaries. Such film can be used for protective clothing when fluids may come into direct contact with the surface of the protective clothing. The film of the present invention will reduce the tendency of the fluid from splashing directly through the capillaries and greatly enhance the protective capability of the clothing.

Fig. 13 shows a layered fabric material that utilizes the film of the present invention. The layered fabric material 70 has a light weight, breathable outer layer 73. The outer layer 73 is usually a paper cover stock that is very light weight and also highly breathable. Next is a layer of non-woven material 75 that is breathable, but provides resistance to the passage of fluids through this layer. In particular, the non-woven material provides good resistance to flow for liquids that come in contact with the non-woven material. A melt blown polypropylene, polyethylene or polyester can be used for the non-woven layer as these materials have acceptable levels of fluid resistance. The next layer on the fabric 70 is a thermoplastic film 79 that has a plurality of perforations 81 and the perforations form capillaries 83 and they are disposed at an angle from about 5° to about 60° with respect to a plane that is perpendicular to the surface 85 of the film. The thermoplastic film 79 is positioned so that the capillaries 83 extend toward and are in contact with the non-woven material. The capillaries 83 formed by the perforations 81 allow the film 79 to be breathable while resisting the direct flow of liquid through the film. Although the film 79 has been shown as being substantially similar to the film 54 shown in Fig. 6, it should be understood that the film similar to the films shown in Figs. 7, 8 and 9

can also be used for the film 79 in the layer fabric material 70. The next layer in the layered fabric 70 is a second layer of non-woven material 87 that is positioned adjacent the surface 85 of the film 79. The second layer of non-woven material 87 is intended to be a layer that comes into contact with the skin of the user of the fabric material 70. If the fabric material is not intended to come into contact with the skin of the user, the second layer of non-woven material 87 can be deleted.

The purpose of the fabric material 70 is to provide a breathable structure that has good resistance to penetration to fluids and more particularly, liquids. The fabric 70 is intended to be used in applications where fluids are splashed or sprayed onto the material and the material provides resistance to the direct pass through of a fluid. This fabric can be utilized in the medical field, hazardous waste field or other areas where people are interested in being protected from spilled or sprayed fluids.

Fig. 14 shows a protective gown 89 and Fig. 15 shows a protective facemask 91 that can be made using the layered fabric material 70. For the protective gown 89, the second layer of non-woven material 87 may be deleted if the gown is to be worn over clothes so that the inner surface of the gown does not contact the skin of the wearer. For both the protective gown 89 and the facemask 91, fluids that are spilled or sprayed will contact the outer layer 73 of the fabric. The fluid will pass through to the non-woven material 75 which provides resistance to fluid penetration. The fluid will then contact the thermoplastic film 79 having the angled capillaries 83. When the fluid engages the thermoplastic film 79, there is no direct path through the film and the velocity of the fluid is significantly reduced. The structure of the layered fabric 70 is intended to prevent direct passage of fluids and provides a much higher level of protection than the breathable materials that are currently available.



Fig. 16 shows the use of the thermoplastic film of the present invention in an absorbent pad or drape 88. In the structure, the film 79 is positioned on a layer of absorbent material 93. The film 79 is disposed so that the capillaries 83 that are formed by the perforations 81 are in contact with the absorbent material 93. With the structure the capillaries 83 act to wick fluid that is on the surface 85 of the thermoplastic film 79 to the absorbent material 93. The angle for the capillaries 83 prevent a direct line of sight along a line that is perpendicular to the surface of the film into the absorbent material 83 so that fluids that are contained in the absorbent material 83 are not easily visible when looking at the surface 85 of the film 79.

Fig. 17 shows another embodiment of a pad or drape 90 that can be made utilizing the film of the present invention. The film 79 is positioned with the surface 85 in contact with a layer of absorbent material 93. The film 79 is positioned so that the capillaries 83 formed by the perforations 81 extent in a direction away from the absorbent material 93. With the capillaries 83 extending away from the absorbent material 93, there is more resistance to strike through for a liquid that is under pressure, such as a sprayed or spilled liquid.

Fig. 18 shows the use of the thermoplastic film 79 as a landscape fabric 94. In this application, the film is positioned with the capillaries 83 extending towards the ground 95 upon which the film is to be positioned. The perforations 81 and the capillaries 83 allow moisture, such as rain, to pass through the film to the ground 95. However, the angled capillaries 83 effectively eliminate or minimize the amount of light that can pass through the film 79. This prevents weed growth and other undesirable growth in areas where the film is positioned. However, since rain can pass through the film, there is no difficulty with disposing of or pooling of rain water. In applications where additional strength is required, a non-woven material 97 can be laminated to the surface 85 of

the film 79 to provide additional strength. It should also be understood that the non-woven material 97 can also be laminated to the opposite side of the film 79 to provide additional strength to the landscape fabric 94.

5           Fig. 19 and 20 show a catamenial or feminine hygiene pad that can be constructed using the film of the present invention. The pad 105 has a layer of perforated thermoplastic film 79 that is positioned over an absorbent core 107. The film 79 is positioned so that the ends of the capillaries 83 that extend from film are in contact with the absorbent  
10           core 107. The absorbent core can include one or more layers of a non-woven material 109 and a highly absorbent wadding or gel material 111. A non-pervious thermoplastic film 113 is positioned on the side of the absorbent core 107 that is opposite to the film 79.

          Figs. 21 and 22 show a diaper product 115 that can be  
15           constructed using the film of the present invention. The diaper 115 has a layer of perforated thermoplastic film 79 that is positioned over an absorbent core 117. The film 79 is positioned so that the ends of the capillaries 83 that extend from the film are in contact with the absorbent core 117. The absorbent core can include one or more layers of a non-  
20           woven material 119 and a highly absorbent wadding or gel material 121. A non-pervious thermoplastic film 123 is positioned on the side of the absorbent core 117 that is opposite to the film 79.

          It should be noted that the film layer 79 shown in Figs. 19-22 will provide masking for fluid that is retained in the absorbent core material  
25           as previously discussed.

          It should be understood that a film similar to the films shown in Figs. 7, 8 and 9 can also be used as the film 79 in the applications shown in Figs. 16-22.

          The above description of the invention is given for the sake of  
30           explanation and various modifications and substitutions, other than those

cited, can be made without departing from the scope of the following claims.

5

**CLAIMS:**

1. A laminated cylindrical screen (14) for perforating a thermoplastic film or sheets (17) comprising:  
two or more relatively thin sheets (31) secured  
10 together to form a cylindrical shape;  
a plurality of apertures (41) positioned in said sheets (31), said apertures (41) having substantially the same geometrical shape, said apertures (41) on adjacent sheets (31) being displaced a distance from about 1% to about 50% of said diameter of said apertures  
15 (41) from said apertures (41) in adjacent sheets (31).
2. The screen (14) of claim 1, wherein said apertures (41) are displaced a distance from about 5% to about 25% of said diameter of said apertures (41) from said apertures (41) in adjacent sheets (31).  
20
3. The screen (14) of claim 1, wherein said apertures (41) in said sheets (31) form a passageway (45) through said screen (14).
4. The screen (14) of claim 3, wherein said passageways (45)  
25 are disposed at an angle from about 5° to about 60° with respect to a plane (47) that is disposed substantially perpendicular to said surface (39) of said screen (14).

5. The screen (14) of claim 3, wherein said apertures (41) are substantially circular and said passageways (45) are substantially cylindrical.

5 6. The screen of claim 5, wherein said apertures (41) are all substantially the same shape.

7. The screen (14) of claim 3, wherein said apertures (41) in said sheets (31) vary in size whereby said passageway (45) converges  
10 as said passageway (45) extends through said screen (14).

8. The screen (14''') of claim 3, wherein said passageway (45''') has a first portion (51) where said apertures (41) are disposed at an angle (A) from about 5° to about 60° with respect to a plane (47)  
15 that extends perpendicular to the surface of said screen and a second portion (53) that is disposed at an angle (B) from about 5° to about 60° with respect to said plane (47), said second portion (53) extending in a direction opposite to said first portion (51).

20 9. The screen (14) of claim 1, wherein said sheets (31) have a thickness from about 1 to about 5 mils.

10. The screen (14) of claim 9, wherein said sheets (31) have a thickness of about 2 mils.

25

11. The screen (14) of claim 1, wherein from about 2 to about 20 sheets (31) are used to form said screen (14).

12. The screen (14) of claim 1, wherein from about 4 to about  
30 10 sheets (31) are used to form said screen (14).

13. The screen (14) of claim 1, wherein said apertures (41) have a diameter from about 2 to about 100 mils.

5 14. The screen (14) of claim 1, wherein said apertures (41) have a diameter from about 7 to about 60 mils.

15. A cylindrical screen (14) for perforating a thermoplastic film or sheets (17) comprising:

10 a relatively thin sheet (31) secured together to form a cylindrical shape;

a plurality of apertures (41) positioned in said sheet (31), said apertures (41) in said sheet (31) forming a passageway (45) through said screen (14) wherein said passageway (45) are disposed at an angle from about 5° to about 60° with respect to a plane (47) that is disposed substantially perpendicular to said surface (39) of said screen (14).

20 16. The screen (14) of claim 15, wherein said apertures (41) are substantially circular and said passageways (45) are substantially cylindrical.

17. The screen of claim 15, wherein said apertures (41) are all substantially the same shape.

25 18. The screen (14) of claim 15, wherein said aperture (41) in said sheets (31) vary in size whereby said passageway (45) converges as said passageway (45) extends through said screen (14).

30 19. The screen (14''') of claim 15, wherein said passageway (45''') has a first portion (51) where said apertures (41) are disposed at

an angle (A) from about 5° to about 60° with respect to a plane (47) that extends perpendicular to the surface of said screen and a second portion (53) that is disposed at an angle (B) from about 5° to about 60° with respect to said plane (47), said second portion (53) extending in a direction opposite to said first portion (51).

20. The screen (14) of claim 15, wherein said screen is formed from a plurality of sheets (31) having a thickness from about 1 to about 5 mils.

10

21. The screen (14) of claim 20, wherein said sheets (31) have a thickness of about 2 mils.

22. The screen (14) of claim 20, wherein from about 2 to about 20 sheets (31) are used to form said screen (14).

15

23. The screen (14) of claim 20, wherein from about 4 to about 10 sheets (31) are used to form said screen (14).

24. The screen (14) of claim 15, wherein said aperture (41) have a diameter from about 2 to about 100 mils.

20

25. The screen (14) of claim 15, wherein said apertures (41) have a diameter from about 7 to about 60 mils.

25

**AMENDED CLAIMS**

[received by the International Bureau on 30 January 1996 (30.01.96);  
original claim 3 cancelled; remaining claims amended (4 pages)]

5

**CLAIMS:**

1. A laminated cylindrical screen for perforating a thermoplastic film comprising:

10 two or more relatively thin sheets secured together to form a cylindrical shape;

a plurality of apertures positioned in each of said sheets, said apertures having substantially the same geometrical shape and same or progressively smaller diameter, centers of said apertures in one sheet being circumferentially displaced in the same direction with  
15 respect to centers of apertures of an adjacent sheet to form a passageway through said screen, said passageway being disposed at an acute angle (A) which is defined between a first line drawn through the center of apertures of adjacent sheets and a second line disposed substantially perpendicular to a surface of said screen, said apertures  
20 preventing a direct line of sight along the second line, said apertures on adjacent sheets being displaced a distance from about 1% to about 50% of said diameter of said apertures from said apertures in adjacent sheets.

2. The screen of claim 1, wherein said apertures in one sheet  
25 are displaced a distance from about 5% to about 25% of said diameter of said apertures from said apertures in adjacent sheets.

3. CANCELLED.



4. The screen of claim 1, wherein said passageways are disposed at said acute angle from about 5° to about 60°.

5. The screen of claim 1, wherein said apertures are substantially circular and said passageways are substantially cylindrical.

6. The screen of claim 5, wherein said apertures are all substantially the same shape.

7. The screen of claim 1, wherein said apertures in said sheets vary in size whereby said passageway converges as said passageway extends through said screen.

8. The screen of claim 1, wherein said passageway has a first portion where said apertures are disposed at the angle (A) from about 5° to about 60°, and a second portion that is disposed at an acute angle (B) from about 5° to about 60° wherein the angle (B) is defined between a third line drawn through the center of said aperture in said second portion and said second line disposed substantially perpendicular to said surface of said screen said second portion extending in a direction opposite to said first portion.

9. The screen of claim 1, wherein said sheets have a thickness from about 1 to about 5 mils.

10. The screen of claim 9, wherein said sheets have a thickness of about 2 mils.

11. The screen of claim 1, wherein from about 2 to about 20 sheets are used to form said screen.

12. The screen of claim 1, wherein from about 4 to about 10 sheets are used to form said screen.

13. The screen of claim 1, wherein said apertures have a diameter from about 2 to about 100 mils.

14. The screen of claim 1, wherein said apertures have a diameter from about 7 to about 60 mils.

15. A cylindrical screen for perforating a thermoplastic film comprising:

at least one relatively thin sheet secured together to form a cylindrical shape;

a plurality of apertures positioned in said sheet, said apertures defining a passageway having a center through said screen wherein said passageway is disposed at an acute angle from about 5° to about 60°, wherein said angle is defined between a first line drawn through the center of said passageway and a second line disposed substantially perpendicular to a surface of the sheet, said apertures preventing a direct line of sight along the second line.

16. The screen of claim 15, wherein said apertures are substantially circular and said passageways are substantially cylindrical.

17. The screen of claim 15, wherein said apertures are all substantially the same shape.

18. The screen of claim 15, wherein said aperture in said sheet varies in size whereby said passageway converges as said passageway extends through said screen.

19. The screen of claim 15, wherein said passageway has a first portion where said apertures are disposed at the angle (A) from about 5° to about 60°, and a second portion that is disposed at an angle (B) from about 5° to about 60° wherein the acute angle (B) is defined between  
5 a third line drawn through the center of said aperture in said second portion and said second line disposed substantially perpendicular to said surface of said screen, said second portion extending in a direction opposite to said first portion.

10 20. The screen of claim 15, wherein said screen is has a thickness from about 1 to about 5 mils.

21. The screen of claim 20, wherein said sheet has a thickness from about 2 mils.

15 22. The screen of claim 20, wherein from about 2 to about 20 sheets are used to form said screen.

20 23. The screen of claim 20, wherein from about 4 to about 10 sheets are used to form said screen.

24. The screen of claim 15, wherein said apertures have a diameter from about 2 to about 100 mils.

25 25. The screen of claim 15, wherein said apertures have a diameter from about 7 to about 60 mils.

## STATEMENT UNDER ARTICLE 19

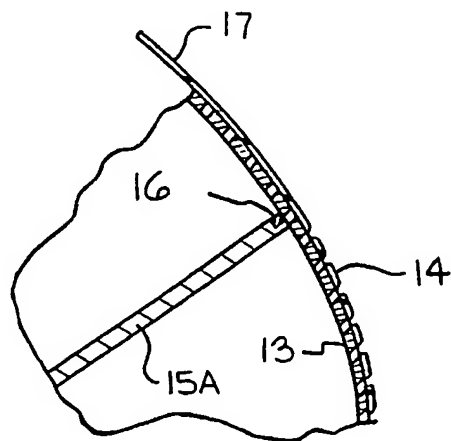
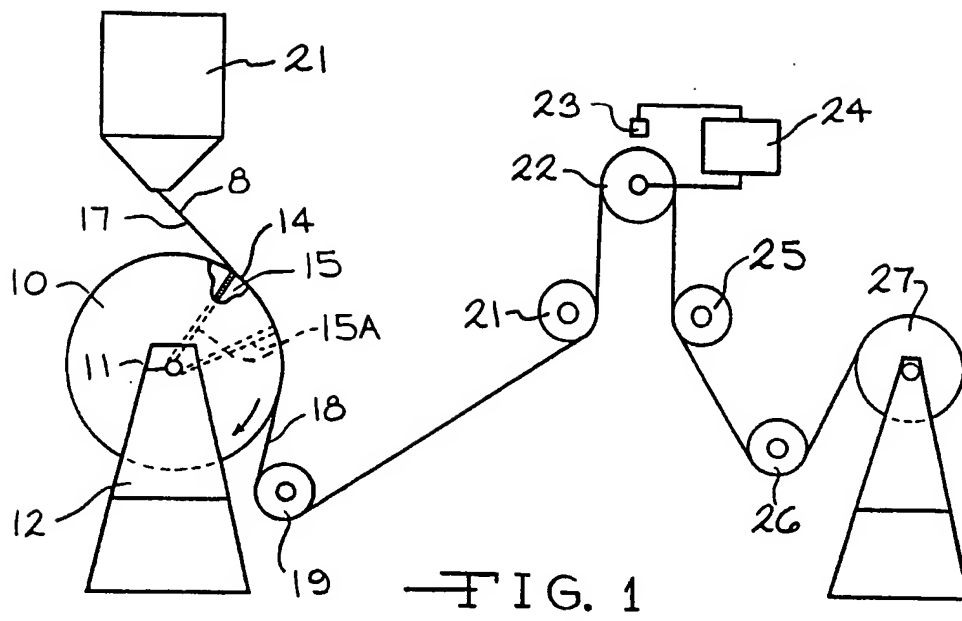
The present invention provides, in part, a laminated cylindrical screen comprising two or more sheets secured together. Each sheet has a plurality of apertures which are circumferentially displaced in the same direction to form a passageway. The passageway is disposed at an angle which is defined between a first line drawn through a center of the aperture and a second line disposed substantially perpendicular to the surface of the screen. The sheets are displaced at a distance from about 1 to about 50% of the diameter of the apertures in one sheet from the apertures in the adjacent sheets. The apertures prevent a direct line of sight along the second line that is perpendicular to the surface of the screen.

The centers of the apertures are circumferentially displaced in the same direction with respect to the centers of apertures in an adjacent sheet. An acute angle is defined as being between a first line drawn through the center of apertures of adjacent sheets and a second line disposed substantially perpendicular to a surface of the screen.

The present invention also provides a cylindrical screen having at least one thin sheet, wherein the apertures therein define a passageway that is disposed at an acute angle to a surface of the screen.

The present invention provides a screen wherein the apertures in the screen are staggered such that the apertures are circumferentially displaced in the same direction to form an angled passageway. Use of the screen of the present invention provides a film having capillaries that are disposed at an angle, which angle acts to block a direct line of sight through the apertures in the film. The film is so produced having a masking characteristic such that fluids passing through the film to an adjacent absorbent structure are not as visible to a user as when the apertures through the film are perpendicular to the surface of the film.

The films are useful in preventing unwanted direct fluid flow through the film. Since the apertures in the film are disposed at an angle, fluid striking the surface of the film does not have a direct path through the capillaries in the film. Rather, the fluid must change direction to pass through the capillaries. Such films are especially useful in providing protective clothing and articles. Further, the capillaries allow the film to be breathable while resisting direct flow of fluid through the film.



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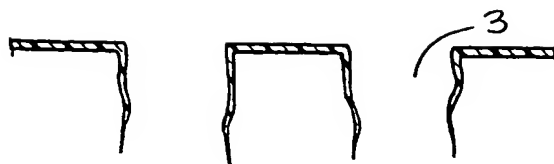


FIG. 3

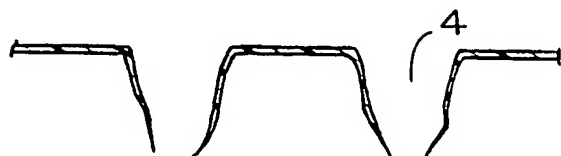


FIG. 4

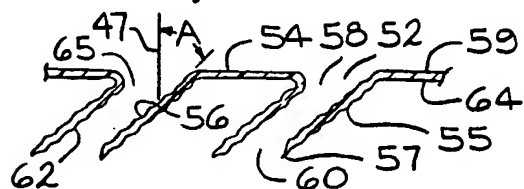


FIG. 6

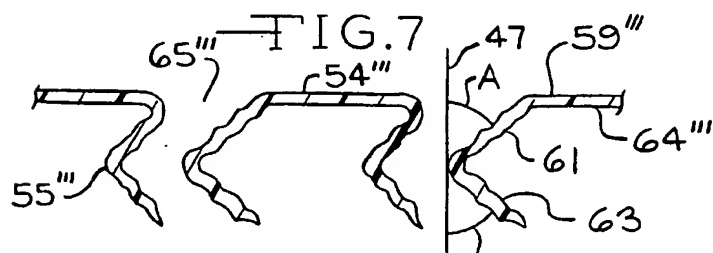
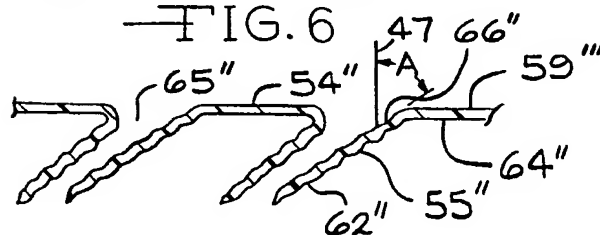


FIG. 8

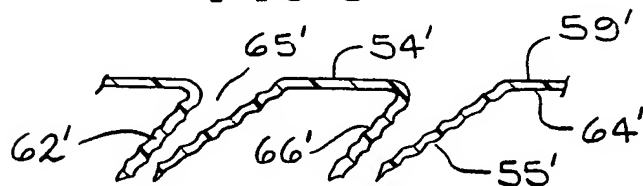


FIG. 9

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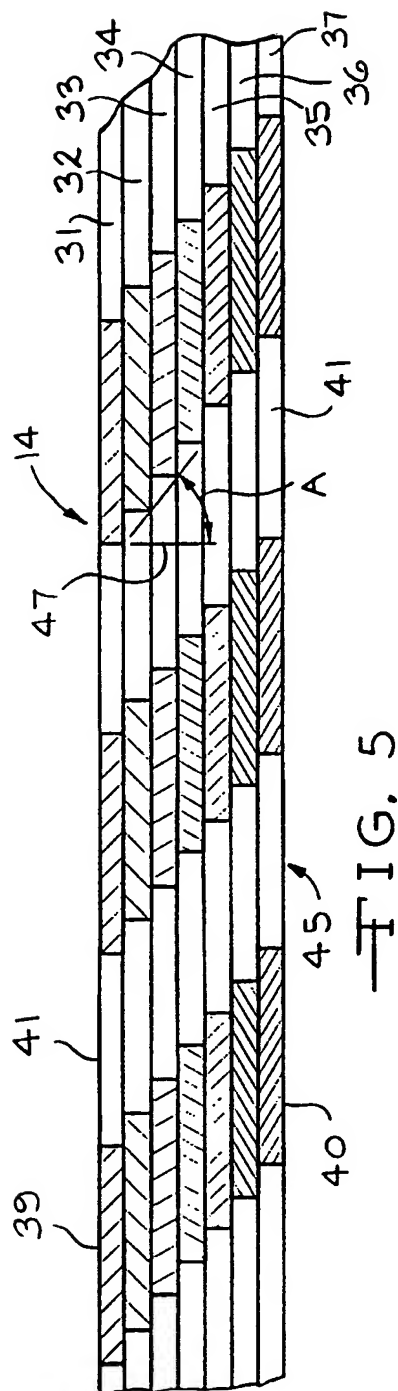


FIG. 5

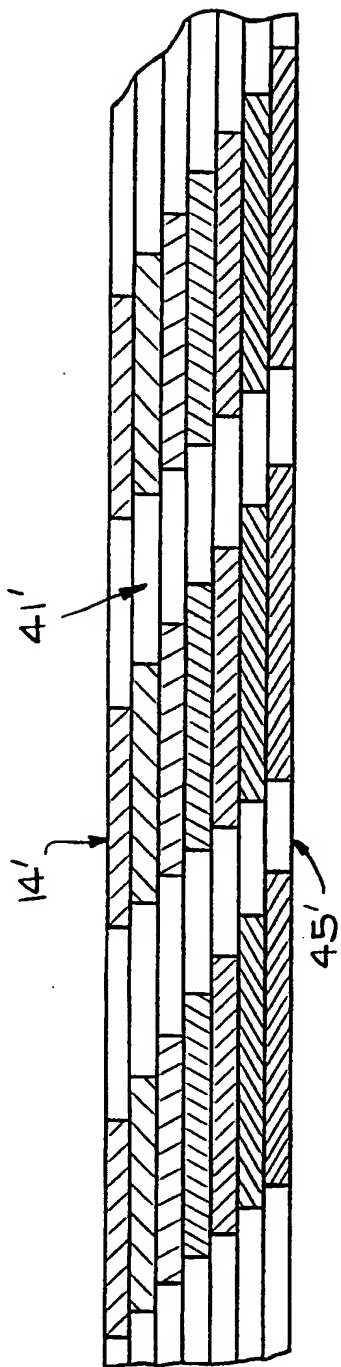


FIG. 10

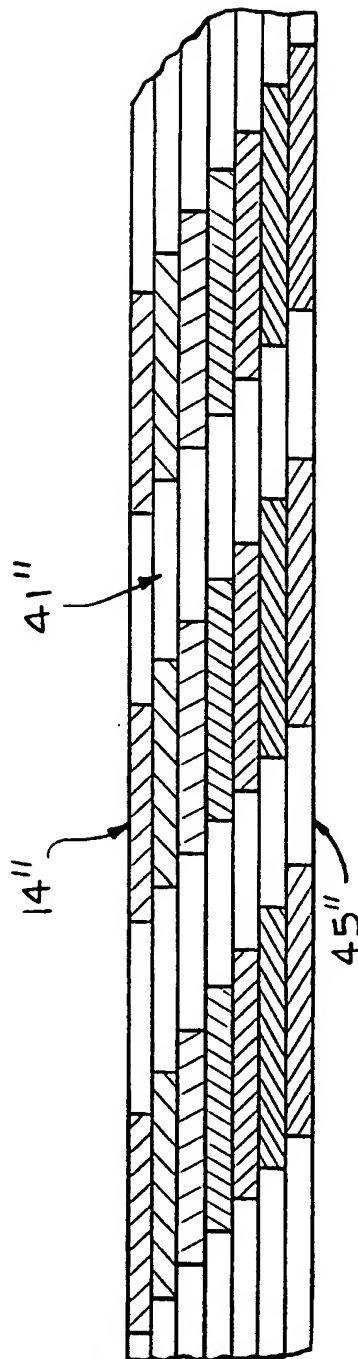
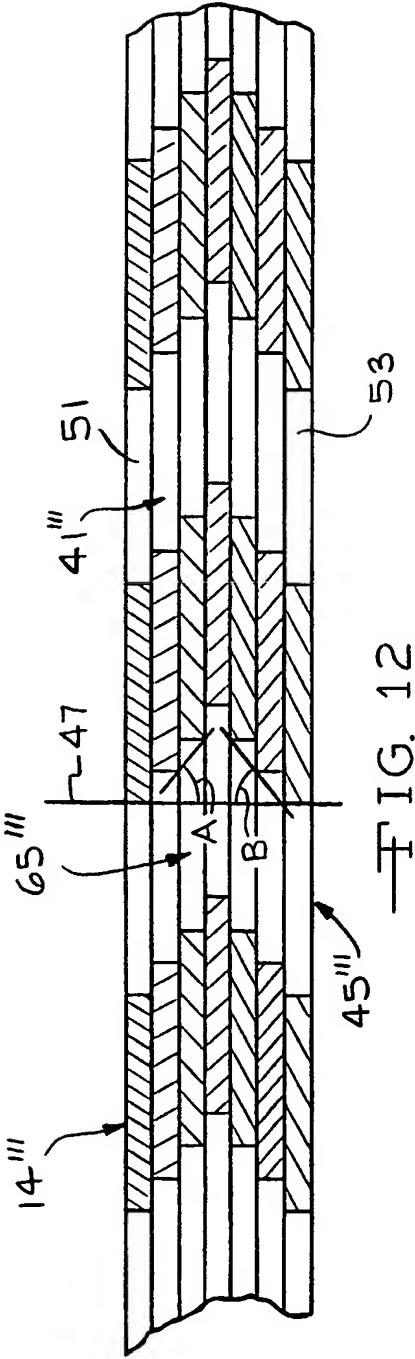


FIG. 11





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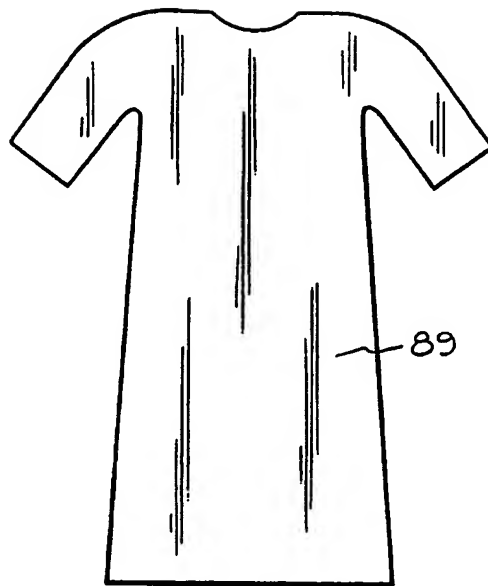


FIG. 14

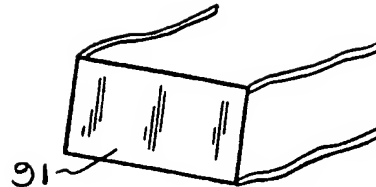


FIG. 15

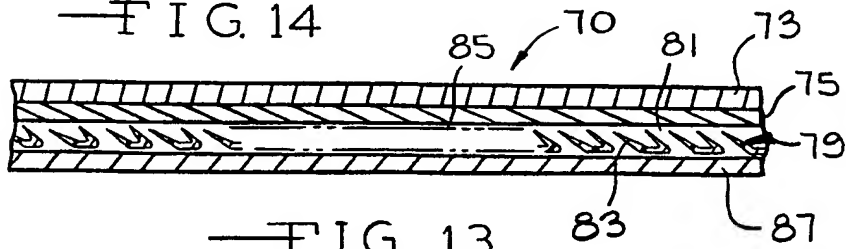


FIG. 13

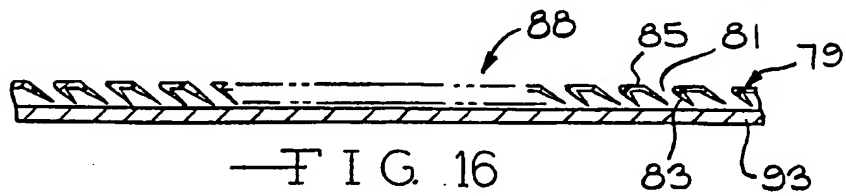


FIG. 16

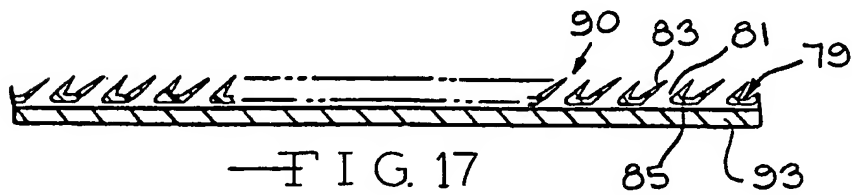


FIG. 17

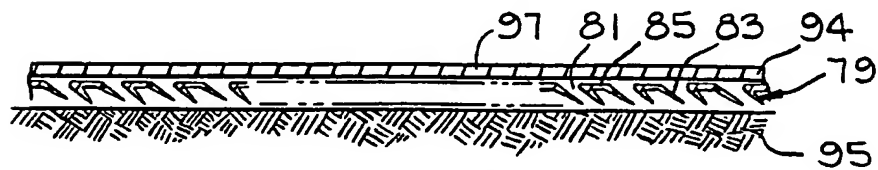


FIG. 18

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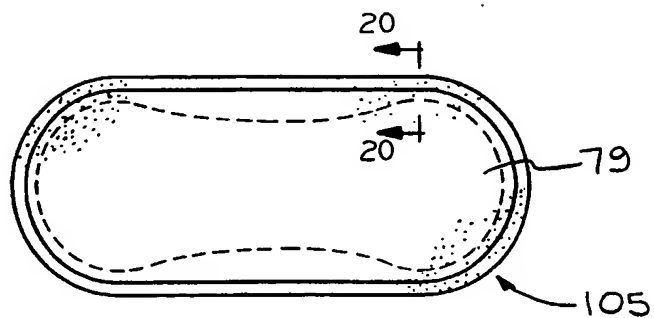


FIG. 19

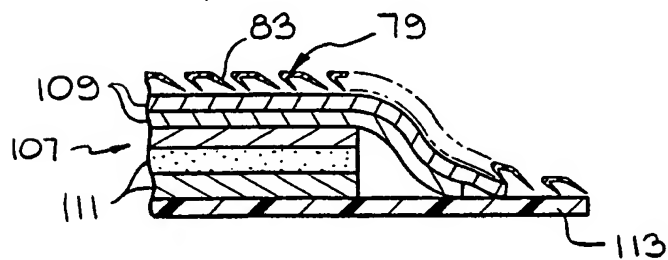


FIG. 20

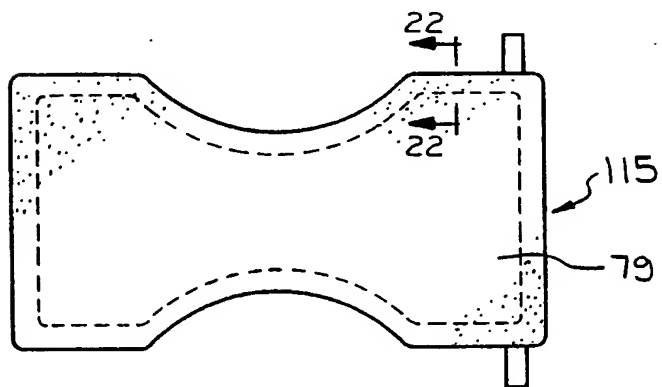


FIG. 21

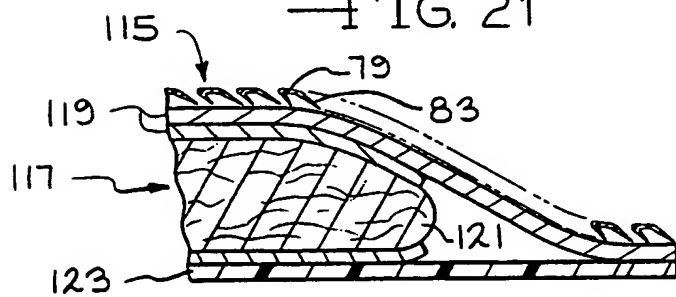


FIG. 22

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US95/09365

<b>A. CLASSIFICATION OF SUBJECT MATTER</b> IPC(5) :B28B 1/48 US CL :Please See Extra Sheet. According to International Patent Classification (IPC) or to both national classification and IPC				
<b>B. FIELDS SEARCHED</b> Minimum documentation searched (classification system followed by classification symbols) U.S. : Please See Extra Sheet. Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)				
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>				
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.		
Y	US, A, 4,509,908 (MULLANE, Jr.) 09 April 1985, see Figs. 4 and 7; column 8, lines 3-12; column 11, lines 32-36 and 37-39.	1-25		
Y	US, A, 4,878,825 (MULLANE, Jr.) 07 November 1989, see Figs. 4, 5, 7, 8 and 12; column 11, lines 8-17.	1-25		
Y	US, A, 4,543,299 (RALEY ET AL) 24 September 1985, see FIGS 7-10; column 7, lines 39-45.	1-25		
Y	US, A, 4,585,156 (RALEY ET AL) 29 April 1986, see FIGS. 7-10; column 7, lines 44-49.	1-25		
Y	US, A, 4,604,156 (RALEY ET AL) 05 August 1986, see FIGS 7-10; column 7, lines 42-47.	1-25		
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.				
<table border="0"> <tr> <td>           * Special categories of cited documents:            "A" document defining the general state of the art which is not considered to be of particular relevance            "E" earlier document published on or after the international filing date            "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)            "O" document referring to an oral disclosure, use, exhibition or other means            "P" document published prior to the international filing date but later than the priority date claimed         </td> <td>           "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention            "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone            "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art            "Z" document member of the same patent family         </td> </tr> </table>			* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "Z" document member of the same patent family
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "Z" document member of the same patent family			
Date of the actual completion of the international search 24 OCTOBER 1995		Date of mailing of the international search report 27 DEC 1995		
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230		Authorized officer Jay Woo <i>[Signature]</i> Telephone No. (703) 308-3793		

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US95/09365

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 4,636,161 (RALEY ET AL) 13 January 1987, see FIGS 9 and 10; column 4, lines 21-24 and 60-63.	1-25
Y	US, A, 4,644,623 (RALEY ET AL) 24 February 1987, see FIGS 9 and 10; column 4, lines 21-24 and 60-63.	1-25

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US95/09365

## A. CLASSIFICATION OF SUBJECT MATTER:

U.S. CL :

425/290,465,466,467; 264/154,504,571

## B. FIELDS SEARCHED

Minimum documentation searched  
Classification System: U.S.

425/290,465,466,467; 264/154,504,571